REMARKS

The independent claims are claims 1 and 7.

Claim 1 has been amended to limit the circuit component to one that is selected from the group consisting of a semiconductor element, a condenser, an inductor and a resistor. Support is found, for example, at page 14, lines 10-12 of the specification. Furthermore, claim 1 has been amended to recite that the at least one of a radiator, a connection terminal, a cover and a circuit component is connected to the conductor layer through a joining member comprising a brazing material. Support is found, for example, at page 13, lines 17-20 of the specification.

As recited in amended claim 5, the ceramic particle is limited to one selected from the group consisting of oxides of alkali metals and alkaline earth metals, Al_2O_3, TiO_2, CeO_2 and mullite.

Claim 7 has been amended to incorporate therein the recitation of claim 9, to the exclusion of "glass forming oxides." Claim 9 has been canceled.

Entry of the amendments and review and reconsideration on the merits are respectfully requested.

Claims 1, 2, 4-6 and 10 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,217,989 to Brody et al. in view of JP 2000-67646 (JP '646) and U.S. Patent No. 5,928,804 to Leddy et al. Claims 7, 8, 9 and 11 were also rejected under 35 U.S.C. § 103(a) as being unpatentable over JP '646 in view of Leddy et al.

The grounds for rejection remain substantially the same as set forth in the previous Office Action, except that the Examiner cited JP '646 as teaching a conductive paste including Fe_2O_3

particle having an average particle size of 1 μm or less within the scope of claims 10 and 11, citing paragraphs [0008]-[0010]. The Examiner similarly applied this disclosure of JP '646 with respect to the ceramic particle having an average particle size of 100 nm or less.

With respect to claim 1, giving this term a broad construction, the Examiner considered via 27 of Brody et al. as being within the scope of the claimed "circuit component."

Although acknowledging that JP '646 does not specifically state that the iron oxide is Fe_2O_3, the Examiner continued to cite Leddy et al. as teaching that it is well known to use Fe_2O_3 as a particle for forming a conductor (citing column 19, lines 30-50). The Examiner concluded that it would have been obvious to select Fe_2O_3 as the iron oxide in the invention of JP '646 (noting that the conductive paste of JP '646 can contain an iron oxide particle in paragraph [0044]), as known in the art and evidenced by Leddy et al. As motivation for the asserted combination, the Examiner suggested that doing so "would have been to use a known material suitable for conductor applications."

Further in this regard, in the "Response to Arguments" the Examiner mentioned that Leddy et al. describes that Fe_2O_3 is a conductive iron oxide particle and concluded that the subject disclosure is pertinent to the problem of finding a conductive iron oxide.

Applicants traverse, and respectfully request the Examiner to reconsider in view of the amendment to the claims and the following remarks.

The invention is directed to a wiring board (claim 1) and a copper paste (claim 7). The wiring board comprises a conductor layer comprising Fe and Cu, and at least one of a radiator, a connection terminal, a cover and a circuit component connected to the conductor layer through a

joining member comprising a brazing material. The wiring board is obtained by coating a copper paste comprising a copper powder, an organic vehicle and an Fe_2O_3 particle mainly comprising Fe_2O_3 as a conductor layer on a ceramic green sheet, and simultaneously firing the ceramic green sheet and coated copper paste. Furthermore, the circuit component is selected from a semiconductor element, a condenser, an inductor and a resistor.

As claimed in claim 5, the copper paste comprises a ceramic particle having an average particle size of 100 nm or less selected from the group consisting of oxides of alkali metals and alkaline earth metals, Al_2O_3, TiO_2, CeO_2 and mullite. As claimed in claim 10, the Fe_2O_3 particle has an average particle size of 1 μm or less.

The copper paste of claim 7 comprises a copper powder, an organic vehicle and an Fe_2O_3 particle mainly comprising Fe_2O_3. As claimed in claim 11, the Fe_2O_3 particle has an average particle size of 1 μm or less.

More particularly, the wiring board of the invention can be obtained by coating a Cu paste containing Fe_2O_3 having a particle size of 1 μm or less onto a ceramic green sheet made from glass, filler and binder, and then firing at 850 to 1,050°C. Because a brazing material or a solder is used for the brazing of the present invention, bulging or separation of the conductor layer does not occur when the board is heated, and a wiring board having a conductor layer exhibiting excellent adhesive strength can be obtained. In addition, by including ceramic particles having an average particle size of 100 nm or less (claims 5 and 9), a wiring board having good plating or soldering property and reduced warpage or waving can further be obtained.

Turning to the cited prior art, the Examiner considered the "circuit component" of claim 1 as broadly encompassing via 27 of Brody et al. One distinction is that the radiator, connection terminal, cover and circuit component are all above the main plane of the wiring board, whereas via 27 of Brody et al. is necessarily inside the circuit board. However, to the extent that the Examiner applies a broad construction to the claims, claim 1 has been amended to limit the "circuit component" to one selected from the group consisting of a semiconductor element, a condenser, an inductor and a resistor to thereby exclude via 27 of Brody et al.

Moreover, the joining member of claim 1 has been further characterized as comprising a brazing material. There is no brazing material connecting via 27 of Brody et al. to line 24. JP '646 and Leddy et al. also do not disclose these characteristic features of amended claim 1. Thus, for this reason alone, it is respectfully submitted that claim 1 and claims 2, 4, 5, 6 and 10 depending therefrom are patentable over Brody et al. in view of JP '646 and Leddy et al.

To the extent that the Examiner construed the "glass forming oxides" of claims 5 and 9 as encompassing the non-conductive powder of JP '646 as described, for example, in paragraph [0015], claim 5 and claim 9 as incorporated into claim 7 have been amended to exclude such glass forming oxides from the scope of the Markush grouping which defines the claimed ceramic particle having an average particle size of 100 nm or less. Further, the Office Action appears to confuse claims 10 and 11 which recite that the Fe_2O_3 particle has an average particle size of 1 μm or less with claims 5 and 9 directed to a ceramic particle having an average particle size of 100 nm or less (i.e., 0.1 μm or less). The claimed average particle size of 100 nm or less excludes the

non-conductive powder of JP '646 having a major-access length of 0.1-0.4 μm disclosed at paragraph [0007] and is not disclosed by JP '646.

Applicants continue to question the combination of Leddy et al. (directed to fuel cells incorporating magnetic composites having distinct flux properties) and JP '646 (conductive paste). The Examiner considered that it would have been obvious to select Fe_2O_3 as the iron oxide in JP '646 because Leddy et al. is said to teach that doing so would have been "to use a known material suitable for conductor applications." However, the passage of Leddy et al. cited by the Examiner relates to magnetic flux enhancement of electrodes with surface modifications including composites which comprise Fe_2O_3 or Fe_2O_4, and has nothing to do with conductors, conductive paste or conductor applications. It is unclear how the Examiner concludes that it would have been obvious to select Fe_2O_3 on the basis of its suitability for the intended use, where the use and environment in Leddy et al. (enhancement of magnetic flux in an electrode) is entirely different from the intended use and environment of JP '646 (conductive paste).

Applicants respectfully request the Examiner to clarify how Leddy et al. is applied in support of the rejection.

Applicants further comment on patentability of the present claims over the cited prior art relative to the firing temperature, use of the wiring board and its effect, as follows.

The present invention provides a copper paste and a wiring board using the same, which can ensure, in the wiring board using copper for the conductor layer, good plating or soldering property of the conductor layer, no generation of bulging or separation of the conductor layer even when the wiring board is heated, and highly reliable connection of a semiconductor element

such as a transistor and diode, heat radiation parts, terminals and various circuit component (page 4, line 20 - page 5, line 3 of the specification). Regarding this last point, in a wiring board having mounted thereon a semiconductor element such as a transistor and diode, the semiconductor generates heat due to input signal to cause elevation of temperature. This in turn deteriorates the properties of the semiconductor element or other circuit component mounted on the circuit board. Therefore, heat radiation is important. For this purpose, in the wiring board, a radiator is connected through a conductor layer in many cases and the conductor layer formed on the wiring board must have sufficient adhesion strength so as to avoid bulging or separation against the heat load (page 3, lines 4-15 of the specification). The prior art proposes addition of a devitrifying glass frit to the copper paste to suppress generation of gas and prevent separation or bulging of the conductor layer. However, the glass comes up to the conductor layer surface and remains to impair soldering or plating properties. Also, the effect of preventing bulging or separation of the conductor layer upon heating is insufficient (page 3, line 22 - page 4, line 19 of the specification).

The present invention solves the above-noted problems of the prior art by incorporating an Fe_2O_3 particle into the copper paste (claims 1 and 7) and firing in an non-oxidizing atmosphere (see claim 6: exposing the coated sheet to a wet nitrogen atmosphere at 650 to 900°C so as to remove organic components). The present Inventors found that incorporating an Fe_2O_3 particle into the copper paste provides an interface where a metal oxide is uniformly present at the interface between the wiring board and the conductor layer so as to enhance adhesion of the conductor layer to the wiring board (page 6, line 3 - page 7, line 8 of the

specification). This effect is realized for Fe_2O_3, but not for other metal oxides such as copper oxide resulting in an interface where a metal oxide is present and an interface where a metal oxide is not present. This results in bulging upon heating from that portion of the interface where the metal oxide is not present (interface having poor adhesive property). See page 6, line 20 - page 7, line 2 of the specification.

JP '646 generally mentions a conductive paste containing a non-conductive powder which becomes ferrous oxide, an iron hydroxide, titanium oxide, silicon carbide, silicon nitride, potassium titanate, boric-acid aluminum, basic magnesium sulfate, beta-wollastonite, and xonotlite. See paragraph [0015]. However, the inventors of JP '646 did not recognize that incorporating an Fe_2O_3 particle into the copper paste specifically solves the above-noted problems of the prior art.

As discussed at page 7, line 9 - page 8, line 10 of the specification, when fired at a temperature higher than 700°C (see claim 6: simultaneously firing the ceramic green sheet and coated copper paste at 850 to 1,050°C after the exposing step), the Fe_2O_3 incorporated into the copper paste acts as an oxidizing agent for Cu in the firing temperature region and slightly oxidizes the entire Cu. Although the amount of Cu that is oxidized is very small, the entire Cu is uniformly oxidized. As a result, the wettability of copper to the liquid phase component of the low-temperature firing porcelain is remarkably enhanced at the firing so as to prevent the generation of local bulging. This aspect of the invention also is not taught or suggested by the prior art relied upon by the Examiner.

Moreover, by further incorporating a ceramic particle having an average particle size of 100 nm or less into the copper paste (see claim 5 and amended claim 7), the plating property or sinterability of the copper powder is enhanced such that a wiring board having good plating or soldering property and reduced warpage or waving is obtained (page 10, lines 7-12 of the specification).

As recited in amended claim 1, the radiator, connection terminal, cover or circuit component is connected to the conductor layer through a joining member comprising a brazing material. The significance thereof in preventing separation or bulging of the conductor layer is discussed bridging pages 13-14 of the specification. Particularly, in a wiring board where a heat radiation member, a connection terminal for packaging, a cover for enclosing an electronic component which generates heat, a circuit component and the like is connected, high reliability can be obtained.

New claims 12-15 further characterize the ceramic particle.

For the above reasons, it is respectfully submitted that the amended claims are patentable over the cited prior art, and withdrawal of the foregoing rejections is respectfully requested.

Withdrawal of all rejections and allowance of claims 1, 2, 4-8 and 10-15 is earnestly solicited.

In the event that the Examiner believes that it may be helpful to advance the prosecution of this application, the Examiner is invited to contact the undersigned at the local Washington, D.C. telephone number indicated below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

Abraham J. Rosner
Registration No. 33,276

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

WASHINGTON DC SUGHRUE/265550
65565
CUSTOMER NUMBER

Date: January 18, 2007